In-beam test of prototype modules for the CBM Silicon Tracking System*

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In December 2013 three groups of the CBM and HADES collaborations tested recently developed prototype detectors in the 2.8 GeV high-intensity proton of COSY, Research Center Jülich, Germany. The beam was provided within a week long shift block dedicated to FAIR detector tests. On the test bench in the JESSICA cave were several prototype modules of the CBM Silicon Tracking System, several prototypes of GEM detectors for the CBM muon detection system developed by the CBM groups at VECC, Kolkata, India, and GSI, and diamond detectors for the T0 determination in CBM and HADES developed by GSI and the Technical University Munich. The beam definition was made with the already approved scintillating fiber hodoscopes built at Wuppertal University.

Prototype STS modules

The modules were to demonstrate the charge collection properties of the recent full-size CBM prototype microstrip sensors CBM05, and the signal transmission to the front-end electronics with optimized micro cables. They were designed at GSI and assembled at SE SRTIIE (team now with LTU) in Kharkov, Ukraine. The read-out was performed with the established front-end boards based on the n-XYTER ASIC. This limited the number of read-out channels to 128 per side, one eighth of all sensor channels. Therefore, the modules were produced in four versions to probe different sensor regions. Two modules used a single CBM05 sensor, one attaching to the central long strips on either side, and another reading out strips of the sensor corners. Two further modules realized, for the first time, also the operation and read-out of daisy-chained sensors, as they will be deployed in the outer regions of STS stations where the track densities allow minimizing the number of read-out channels by using particularly long strips.
The STS set-up on the beam table is shown in the left panel of Fig. 1. Two reference stations (STS 0, STS 1) defined the particle trajectories for impact on station STS 2 comprising a module under test. Such a module, here with daisy-chained sensors and the 25 cm long read-out cable, is shown in the right panel of the figure.

Measurement programme

The beam profile was adjusted to a diameter of about one centimeter. As the CBM05 microstrip sensors provide an active area of 6.2 cm by 6.2 cm, the middle station could be adjusted to probe certain sensor regions with beam. In addition to adjusting the horizontal and vertical position, also the impact angle of the beam was changed by rotating the station around the vertical axis. Several tens of runs with large statistics were taken for every module to study the charge collection properties as a function of various parameters, including bias voltage, strip length, signal path length, and beam incidence angle. Detailed analyses are being performed.

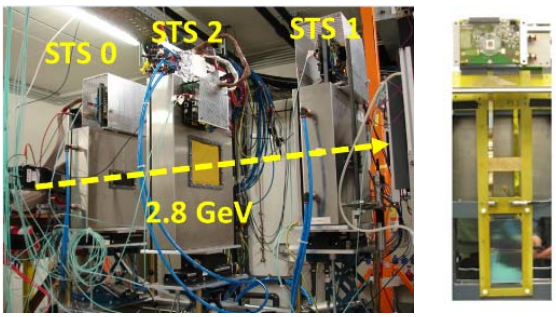

Figure 1: Prototype silicon tracking system in the JESSICA cave at COSY. Station STS 2 comprised the modules under test; one is shown in the right panel.

First results

The performance of the modules shall be illustrated with charge spectra, here from a module with two daisy-chained CBM05 sensors operated in self-triggered read-out mode. The distributions show, for both the n and p sides of the sensor, the charge collected on all of the 128 channels, after transmission through the read-out cables. The small peak is residual noise, the large peak charge from transient protons.

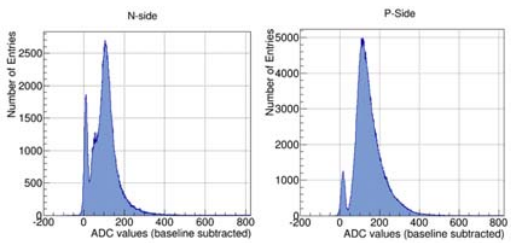

Figure 2: Charge spectra from both sides of a module.

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